WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005MD89B

Title: Chemical and Biological Availability of Zinc in Road Runoff Entering Stormwater Retention Ponds

Project Type: Research

Focus Categories: Non Point Pollution, Sediments, Toxic Substances

Keywords: retention ponds, zinc, bioavailability

Start Date: 03/01/2005

End Date: 02/28/2006

Federal Funds: $14,472

Non-Federal Matching Funds: $36,311

Congressional District: 2

Principal Investigators:
Ryan E. Casey
Towson University

Steven M. Lev

Joel Wade Snodgrass
Towson University

Edward R. Landa

Abstract

Highway runoff has the potential to negatively impact receiving systems due to transport of contaminants that accumulate on road surfaces. Recent work by Greenstein et al. (2004) showed that dissolved Zn likely caused observed toxicity in parking lot runoff after simulated rainfall, with tire wear particles and motor oil being suspected Zn sources. Tire wear particles, contain about 1% Zn and make up approximately one-third of the vehicle derived particulates in highway runoff (Breault and Granato 2000). Davis et al. (2001) estimated that bout 15 to 60% of the Zn in urban stormwater runoff comes from tire wear. Recent work from the USGS (Councell et al. 2004) has shown that tire wear particles constitute a significant source of Zn to the environment, with release inventories

similar to waste incineration; during 1999 approximately 10,000 tons of Zn was released to roadways in the U.S.

This study will quantify the amount and distribution of Zn in a stormwater retention pond receiving highway runoff. Because these ponds serve as habitat for a variety of species, the chemical and biological availability of Zn to biota is integral to assessing the habitat quality of retention ponds. This study will relate the amount and speciation of Zn in the retention pond to Zn inputs through highway-derived runoff events. The proposed work will also relate the chemical speciation and availability of particulate Zn to the bioavailability and toxicity of Zn to pond organisms (larval amphibians).

The site to be investigated is located next to a four-lane highway from which it receives runoff through a single culvert. Previously we investigated amphibian usage of this pond; five species of anurans are known to utilize the pond as a breeding site (Massal 2003). Zn in amphibian tissues and retention pond sediments were highly elevated at this site in 2001 and 2002 (Casey et al. in press). A recent analysis of storm water (11-4-04) collected at this site suggests that roadway particulate matter transported during runoff events is the dominant source of Zn in this system. A first-flush water sample contained total suspended solids of 150 mg L-1; truly dissolved Zn was 55 mg L-1; total exchangeable Zn was 401 mg L-1. The difference between these values is due to exchangeable Zn released from particulates upon acidification and along with the suspended solids data can be used to determine the exchangeable Zn concentration of the solids themselves: 2309 mg Zn kg-1 solids. Leachable Zn in the particulate phase (6 M HNO3 and 30% H2O2 digestion) was 2411 mg Zn kg-1. Because exchangeable Zn constituted 96% of the leachable Zn, most of the Zn entering retention ponds may be bioavailable.

This project will involve characterization of the Zn distribution and speciation in pond sediments, surface soils and roadway particulate matter collected around this site. The use of sequential extraction procedures will allow us to quantify the fractions of Zn found in the solid phase and predict their availability to organisms in this receiving system. In addition, we will quantify the actual loading of Zn in the aqueous and particulate phases during storm runoff. By sampling water and discharge of runoff into the pond, we will determine both the magnitude and temporal characteristics of Zn loading (e.g. first-flush effect). We will also evaluate the biological implications of roadway runoff contamination of sediments in this system. We will conduct bioassays with larval amphibians to quantify effects of exposure to retention pond sediments. We will also conduct an assay that will determine the relevant routes of exposure (contaminated sediment vs. contaminated periphyton diet) in this system.

This study will advance our understanding of the source material responsible for Zn loading in roadway runoff and its biological implications. The resulting data will facilitate more informed management of roadway runoff and receiving systems in a region that is becoming increasingly urbanized.